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15. Supplementary Notes

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16. Abstract (MAXIMUM 200 WORDS)

Leeway behavior, the effect of wind on floating objects, of a variety of small survivor objects and situations is required to provide reliable inputs into Coast Guard search planning models. This series of leeway experiments extends a series of leeway experiments employing GPS navigation, miniature electromagnetic or acoustic current meters, and on-board weather stations. The experiments directly measured the leeway of small objects that may be involved in Search and Rescue activities by attaching current meters to the leeway objects. Collecting meteorological data continuously at or near the drift object improved the relationship of these data to the particular leeway object. Internal recording of measurements of wind and current, along with satellite positioning and telemetry, permitted greater data recovery and the ability to gather data during severe weather. A method to measure leeway of extremely small objects was developed making use, for the first time, of new current meter designs. Leeway values as a function of wind velocity were developed for a Person-In-Water (PIW) (wearing a personal flotation device or survival suit), Wharf Box, Sea Kayak, and Windsurfer. The leeway values are presented in three forms for search planners using the manual method, CASP (Computer Assisted Search Planning) program, and an advanced version of a leeway model that will replace the current CASP. This report concludes that the methods and instrumentation developed to measure the leeway of small survivor objects such as PIWs are accurate. Leeway values developed for the PIWs and the three small craft furnish the search planner, for the first time, with verifiable leeway planning guidance.

17. Key Words	18. Distribution Statement
Search and Rescue, leeway, leeway drift, survivor craft, PIW, person-in-water, person-in-the-water, wharf box, windsurfer, sea kayak, survival suit	This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

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EXECUTIVE SUMMARY

INTRODUCTION

When the Coast Guard prepares to conduct a search, search planners need to define an area over which the search will be conducted. The search planner's goal is to define the smallest search area that contains the survivors or survivor craft with a reasonable and predictable level of certainty. The search planner needs information about the Last Known Position (LKP) of the search object, the time of that LKP, the ocean currents and winds in the area of the search object, and the type of the search object. The size of the search area is directly related to the certainty to which these data are known.

The movement of survivors or survivor craft through the water, caused by wind acting on their exposed surface, is termed leeway. Both ocean currents and the leeway will displace the survivor or survivor craft from its LKP. While current-induced search object motion generally follows the surface water movement, the action of wind on a survivor or survivor craft leads to a drift direction that is usually different from the downwind direction. Since the only vector directions that search planners have at their disposal are those for wind and current, the direction of the leeway drift vector must be computed based upon individual leeway object characteristics. This report provides leeway vector data for four common search objects.

The concern for the effect of wind on survivor craft during World War II SAR operations dates to a study conducted by Pingree (1944). Since that original study, attempts have been made to improve and refine leeway search guidance and to expand the variety of SAR objects that have leeway drift information available. In the early 1990's, technology dramatically changed our capabilities to measure leeway directly. Satellite-based navigation and communications enabled objects and instruments to be tracked with precision and for their data to be recovered even in cases of equipment loss. Small self-contained current meters, either electromagnetic or acoustic technology, enabled a current-measuring capability to be incorporated into the drift object and for the movement of the object with respect to the water to be measured directly. Compact weather stations and drifting (or moored) meteorological buoys permitted reliable wind data collection at or near the drift object during even severe conditions. Records of leeway drift and leeway tracks are, as a consequence, much more accurate than in past records. More importantly, the variability of the record can be considered a reflection of the variability of leeway rather than of the noise in the data.

The data analyzed in this report were collected during a field experiment conducted offshore of Delaware Bay from 17 January 1998 through 1 February 1998. This experiment employed the modern methods and instrumentation described above. Leeway data were collected during eighteen leeway runs for a Person-In-Water wearing a Type I personal flotation device (PIW-I), a Person-In-Water wearing a survival suit (PIW-SS), a Windsurfer, a Sea Kayak, and a Wharf Box with 1- and 4-person loading. Leeway was directly measured using either an attached or tethered current meter. Drift and wind data were analyzed to determine downwind and crosswind leeway speed as a function of wind speed adjusted to the 10-meter height. Statistics

that provide a measure of the uncertainty or variability of the leeway drift were computed as inputs into Coast Guard Search and Rescue (SAR) planning tools.

RECOMMENDATIONS

Based upon analysis of the collected data, this report recommends leeway values to the search planner for the Wharf Box, the two configurations of PIWs, the Windsurfer, and the Sea Kayak (see Tables 5-1 through 5-9). The presentation of leeway values and the form in which they are used is dependent on the particular search planning application. In the case of manual search planning, the values found in Table 5-1 are recommended. The appropriate inputs for the presently used U.S. Coast Guard numerical SAR planning tool, CASP, are presented in Table 5-2. For the next generation of SAR planning tools that may use downwind and crosswind leeway components, Tables 5-3 through Table 5-9 provide the necessary coefficients and statistical measures.